

Neutron Scattering for Condensed Matter Research

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Transformative Hadron Beamlines Workshop
Brookhaven National Lab
July 22, 2014

Neutron scattering at BNL



Brookhaven Graphite Research Reactor



High Flux Beam Reactor

Condensed Matter Physics & Material Science Dept.

Neutron Scattering Group: Tranquada, Gu, Hücker, Xu, Zaliznyak

Flucteam: Billinge, Bozin

Correlated Electron Materials: Aronson



Gen Shirane

Julius Hastings

Spallation sources

SNS, ORNL

- 16 instruments operating
- 3 in commissioning
- 1 under consideration
- 4 uncommitted beam lines

source:

- 1.5×10^{14} protons/pulse @ 1.4 MW
- 1 GeV proton energy
- 695 ns proton pulse length
- $\sim 10 \mu\text{s}$ neutron pulse length
- 60 Hz

recent operations: 1.3 MW

Priority: build Second Target Station

- 10 Hz
- optimized for large λ neutrons
- short pulse



J-PARC MLF 0.3 MW

ISIS 0.2 MW

ESS planned: 5 MW
long pulse

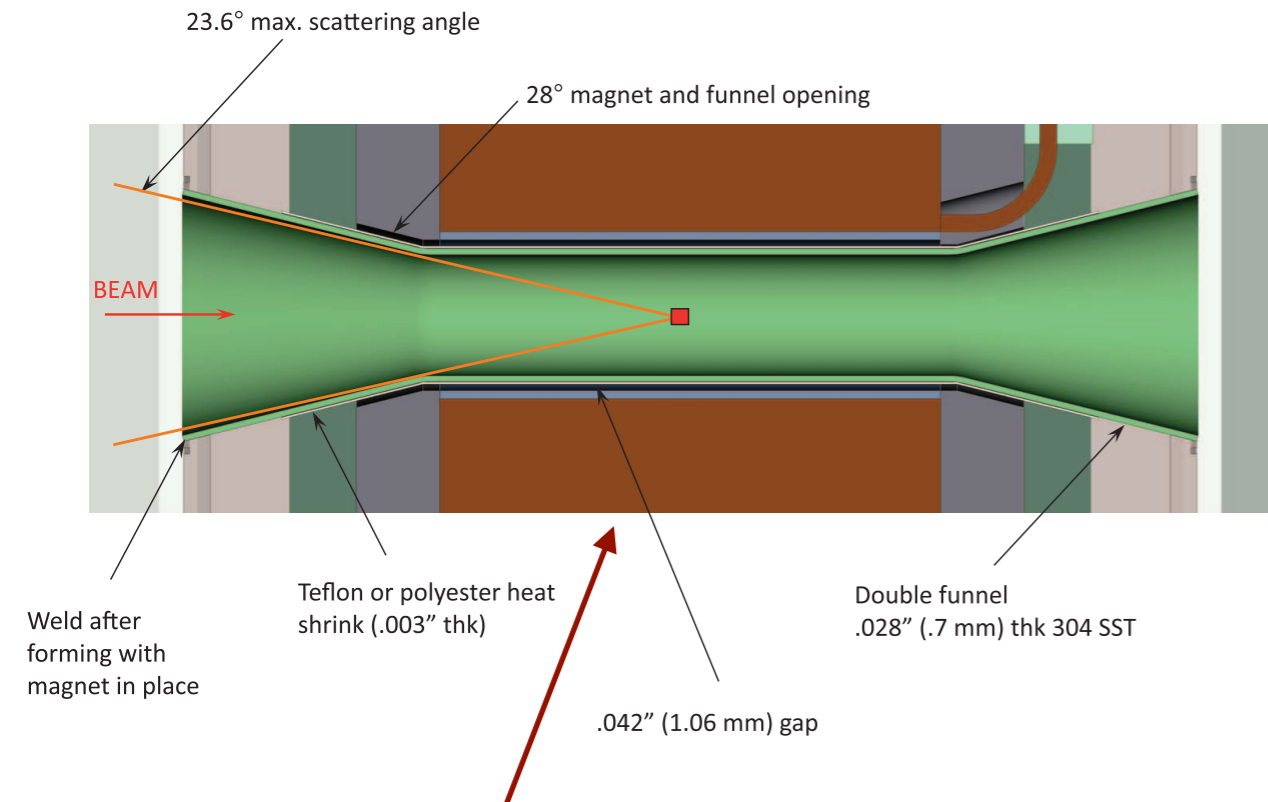
Opportunity: Time-dependent scattering

- Match intensity and timing of pulses to sample requirements
- Example: high, pulsed magnetic fields, > 30 T
- Science:
 - Phase transitions in magnetic systems
 - Superconductivity
 - Suppress SC order, induce competing order
- Neutron energy: 10-100 meV
 - Requires moderated beam, low background

Current magnet capabilities

- 17 T dc vertical field (ILL, HZB)
- 17 T dc horizontal field (U. Birmingham)
- 25 T dc horizontal field (HZB+HFML, under construction)
- 30 T pulsed (SNS, ILL)

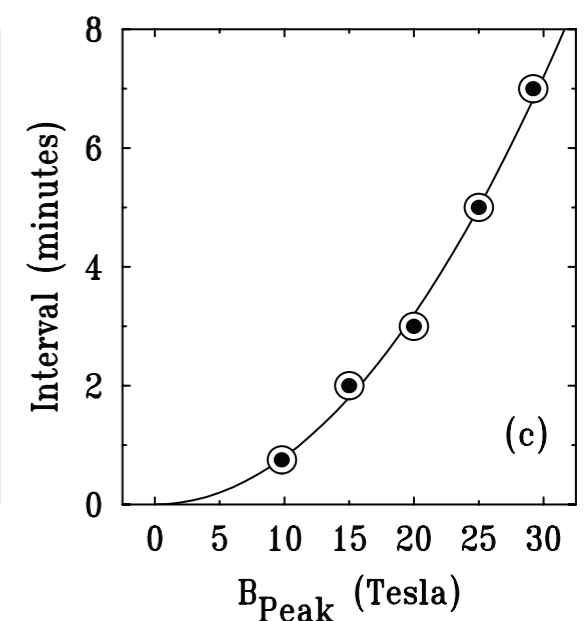
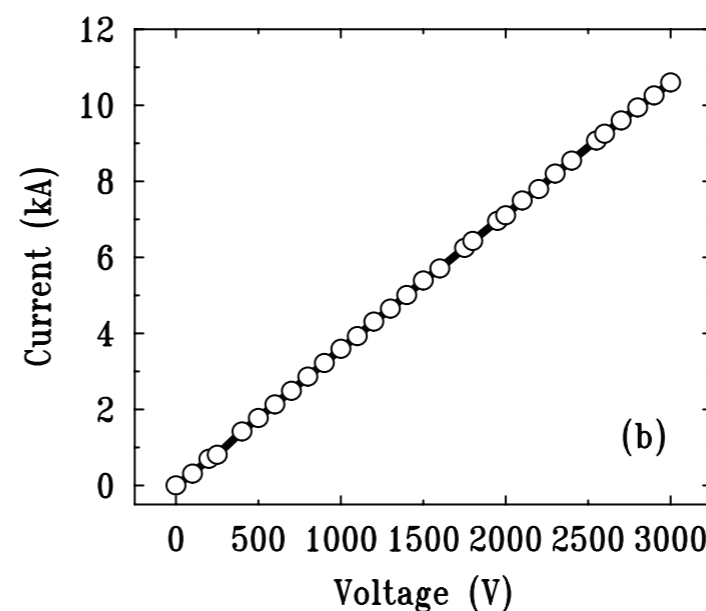
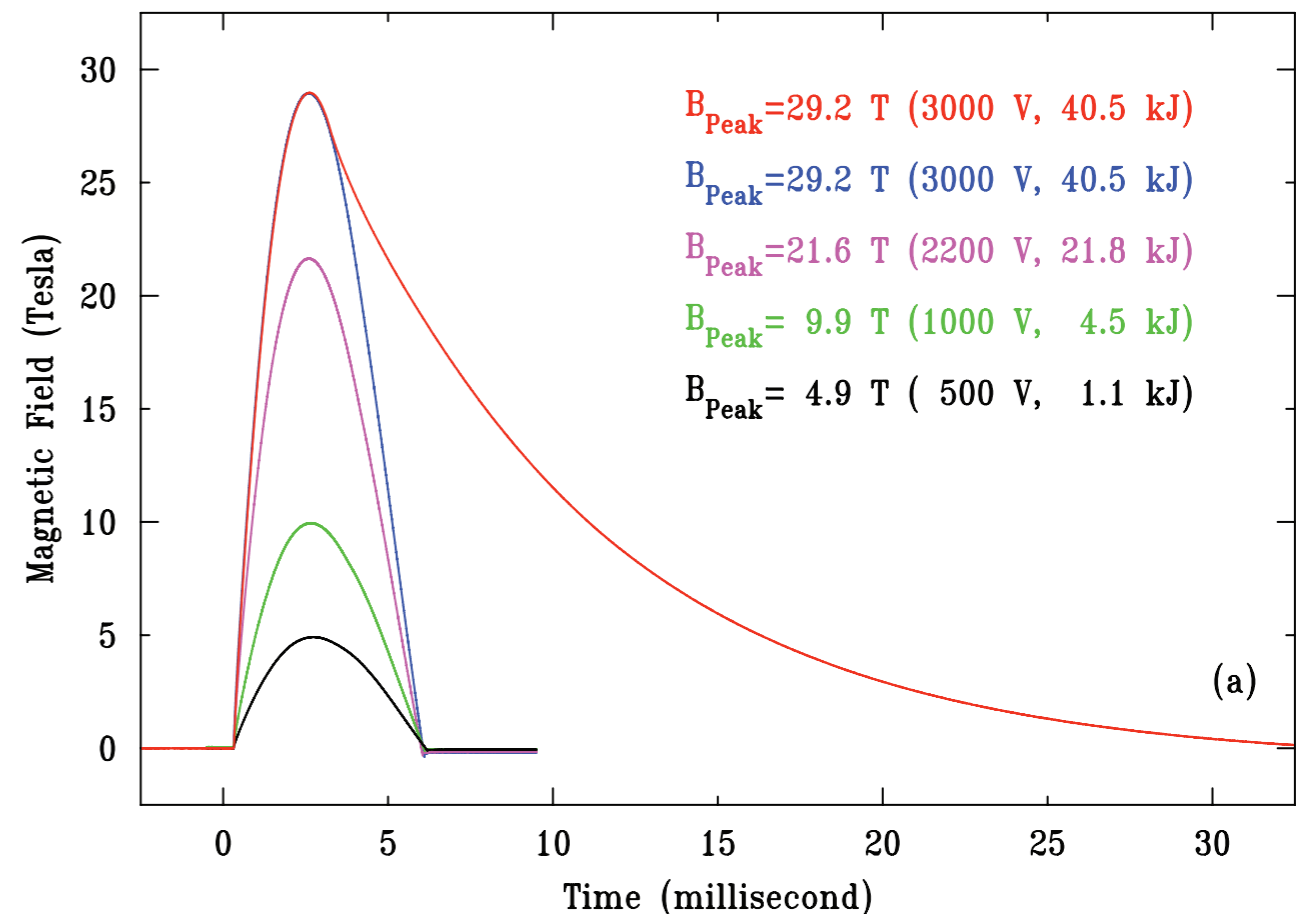
30-T pulsed field magnet



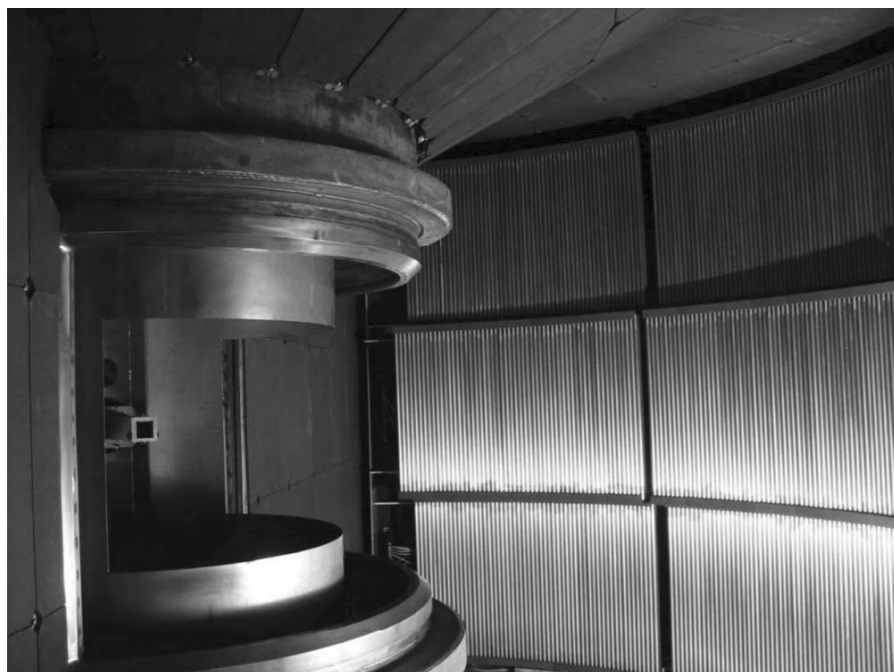
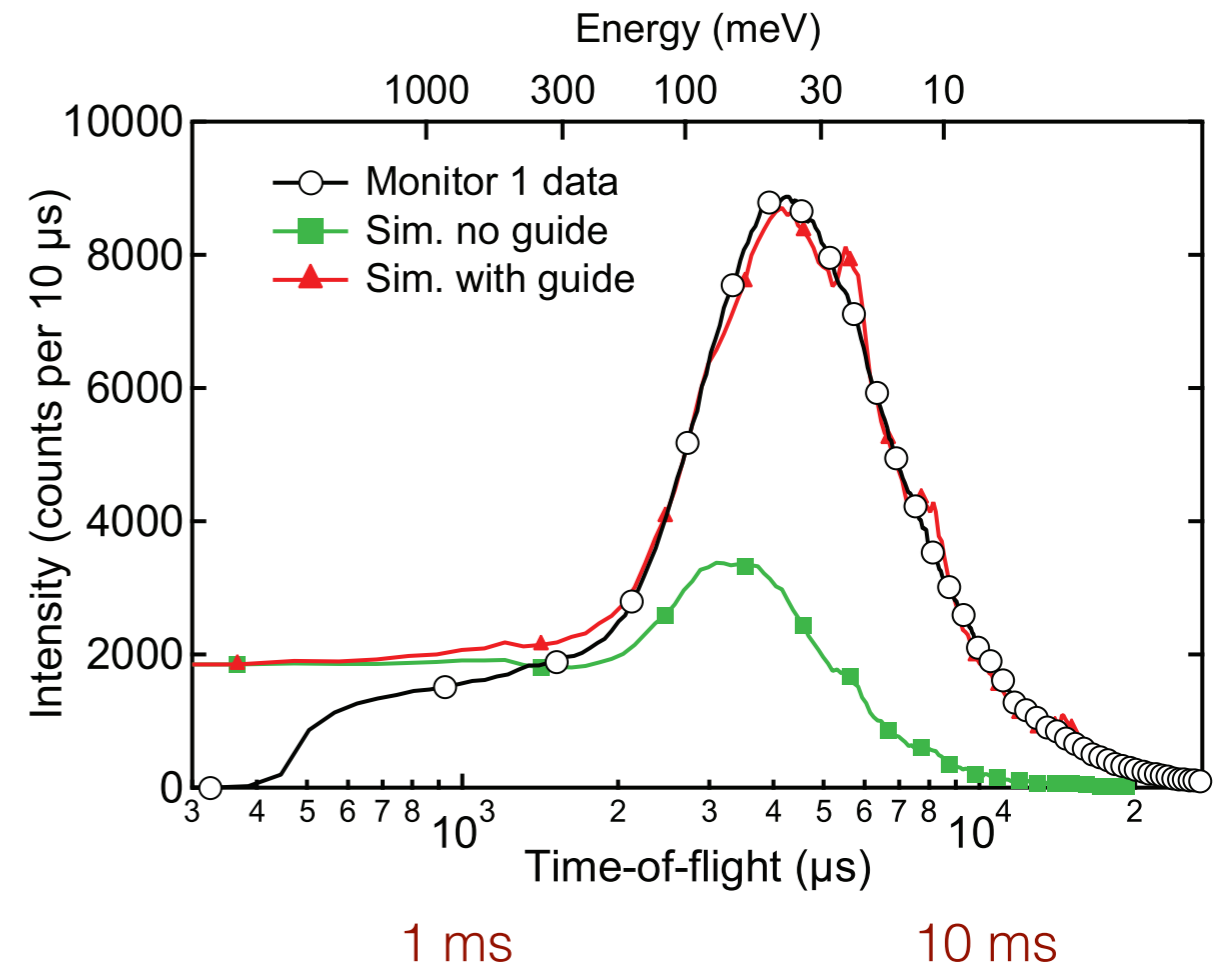
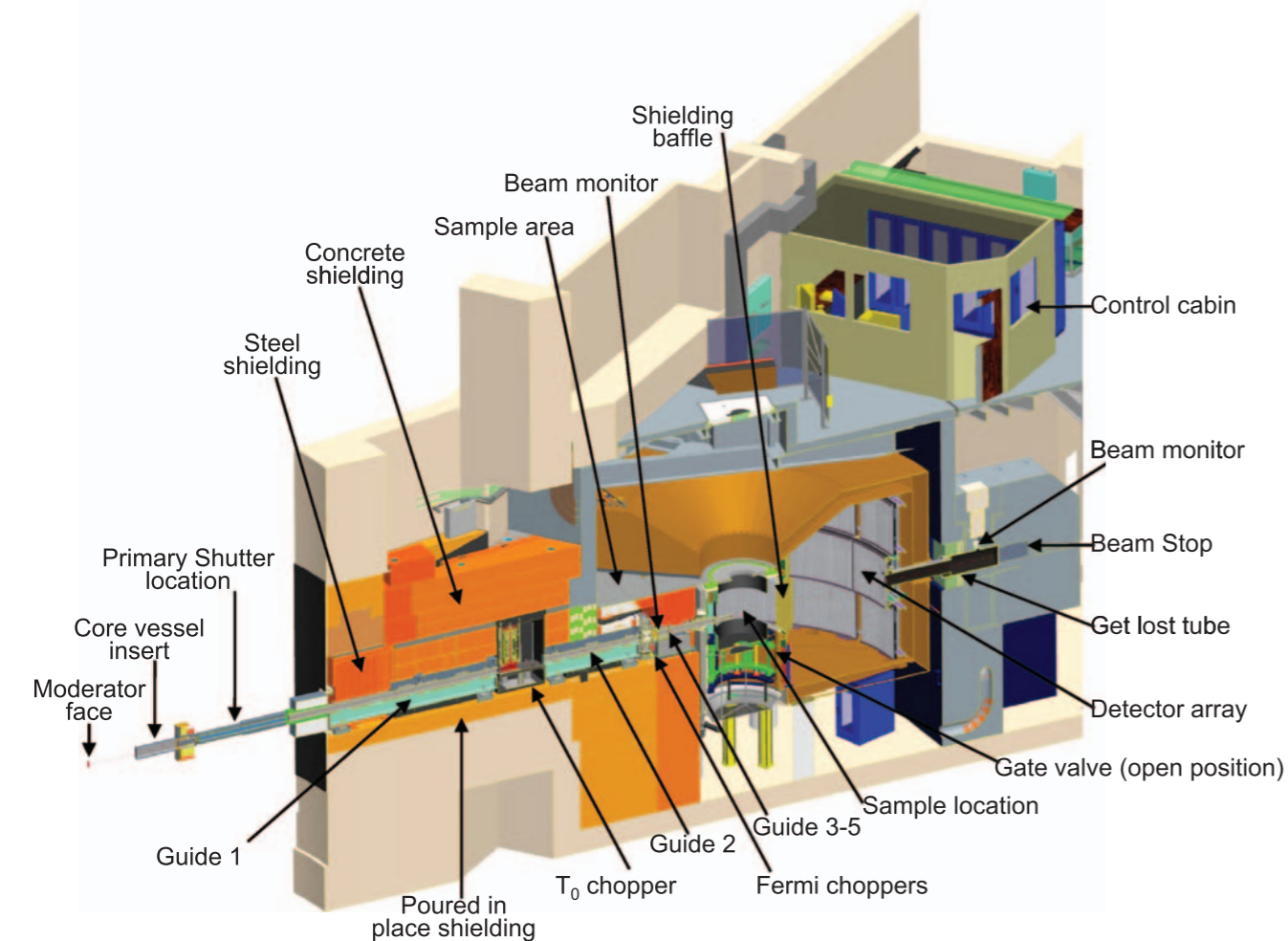
magnet solenoid cooled in LN_2

System built for the APS
Coil built at Tohoku U. by H. Nojiri
40-kJ capacitor bank, charge in 25 s

Z. Islam *et al.*,
Rev. Sci. Instrum. **83**, 035101 (2012)



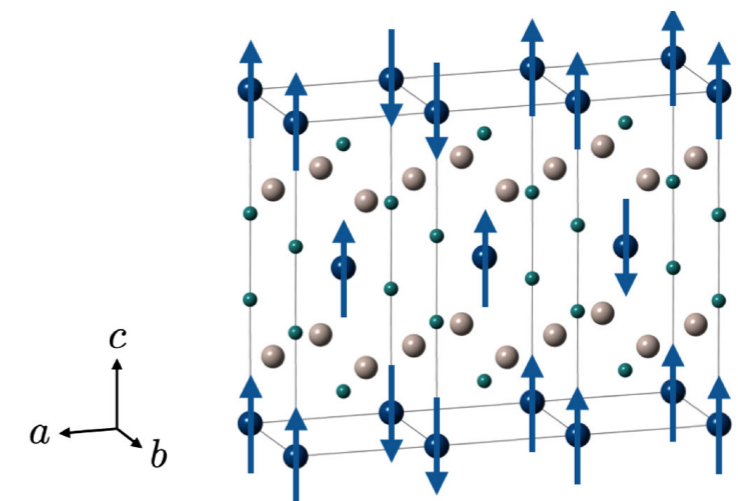
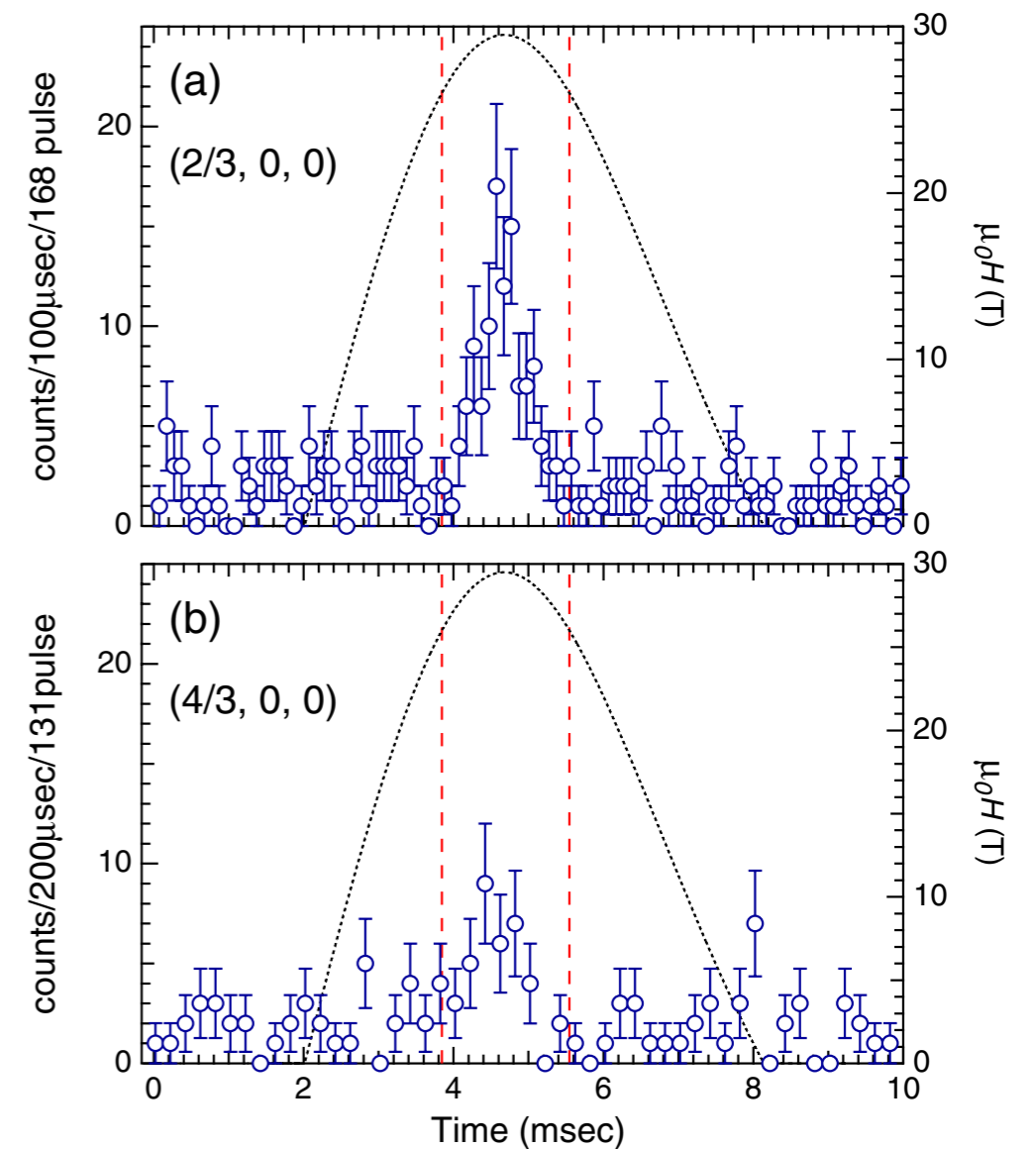
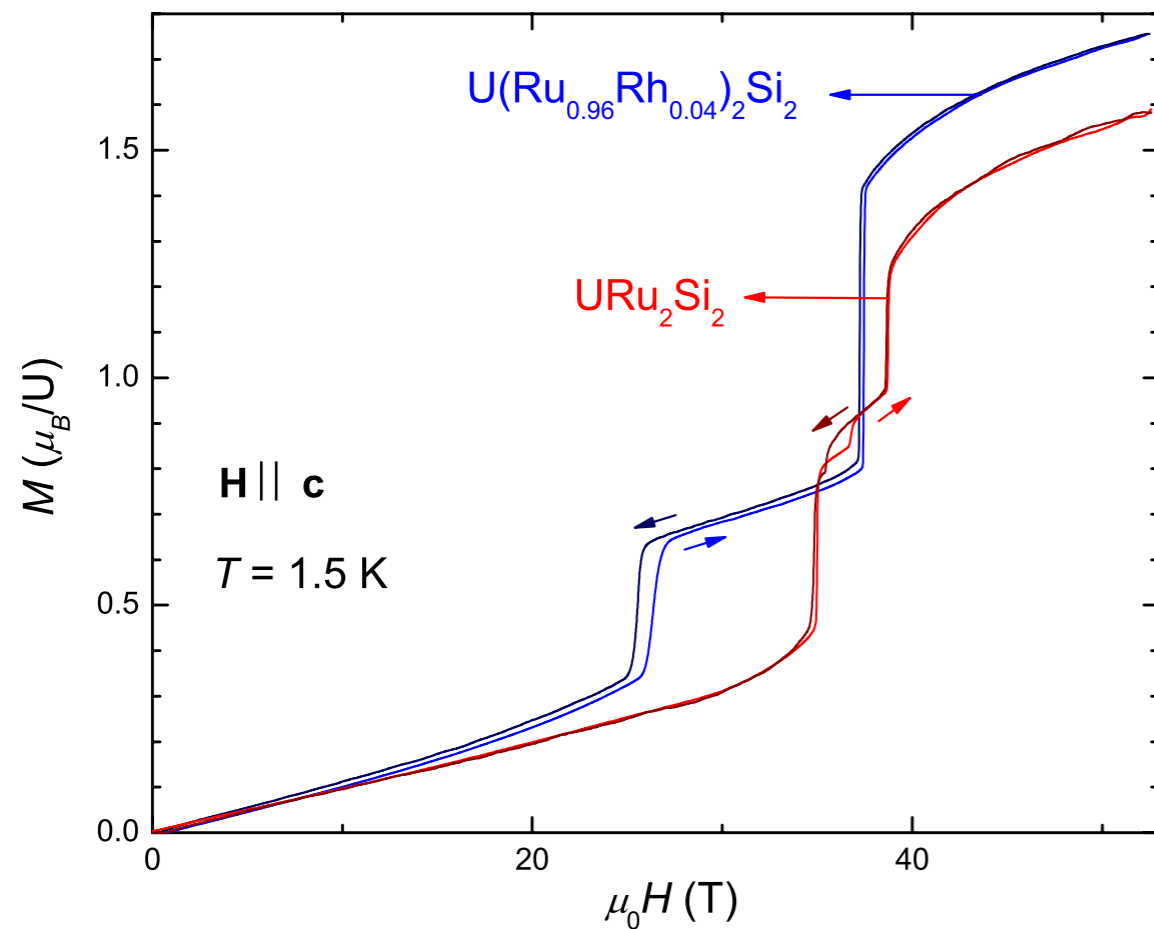
ARCS spectrometer at SNS



Ambient water moderator
11.8 m to monitor

D.L. Abernathy *et al.*,
Rev. Sci. Instrum. **83**, 015114 (2012)

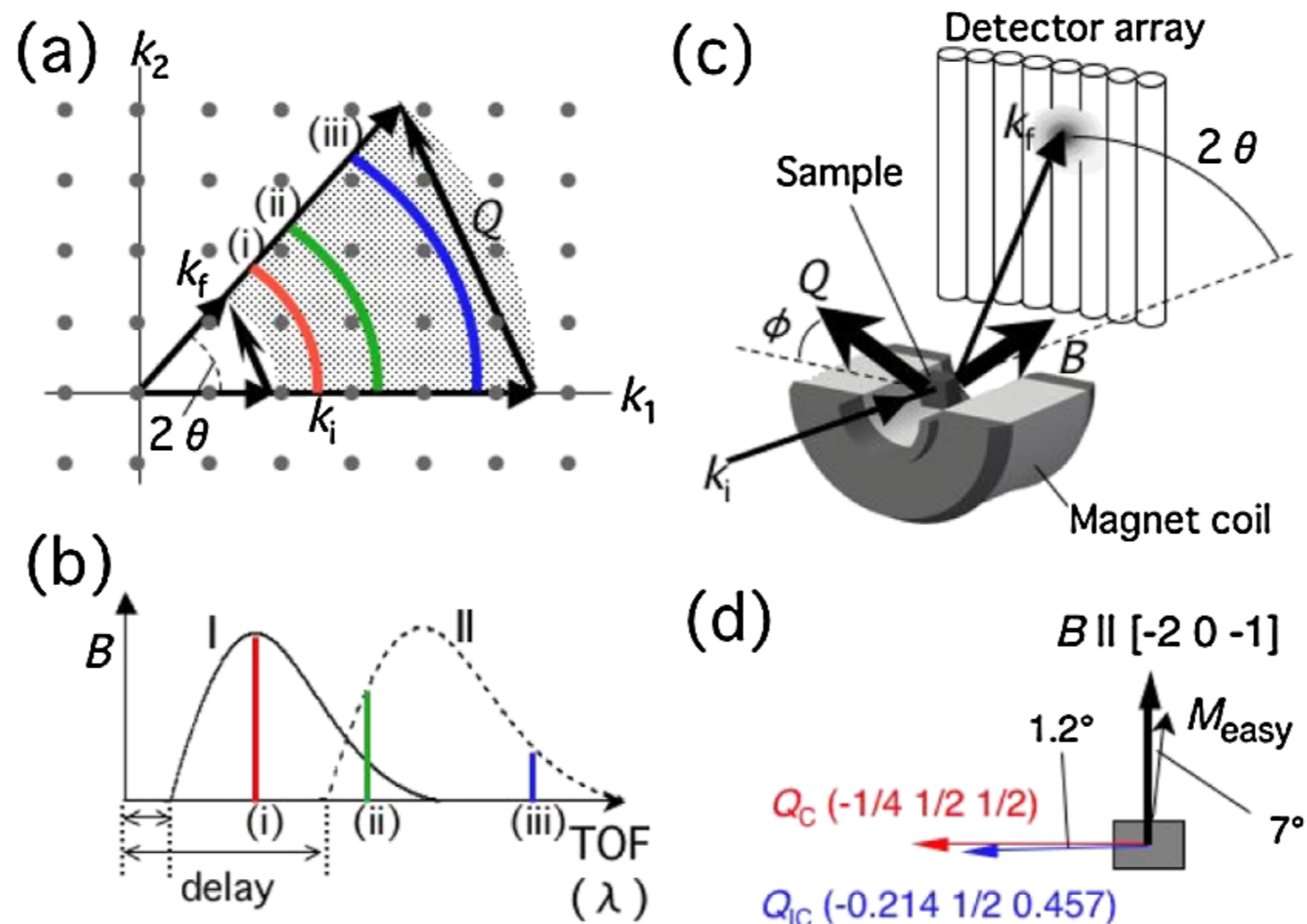
Magnetic transition in $\text{U}(\text{Ru}_{0.96}\text{Rh}_{0.04})_2\text{Si}_2$



Experiment performed on IN22 at ILL.
Triple-axis spectrometer operated in 2-axis mode.

K. Kuwahara *et al.*,
Phys. Rev. Lett. **110**, 216406 (2013)

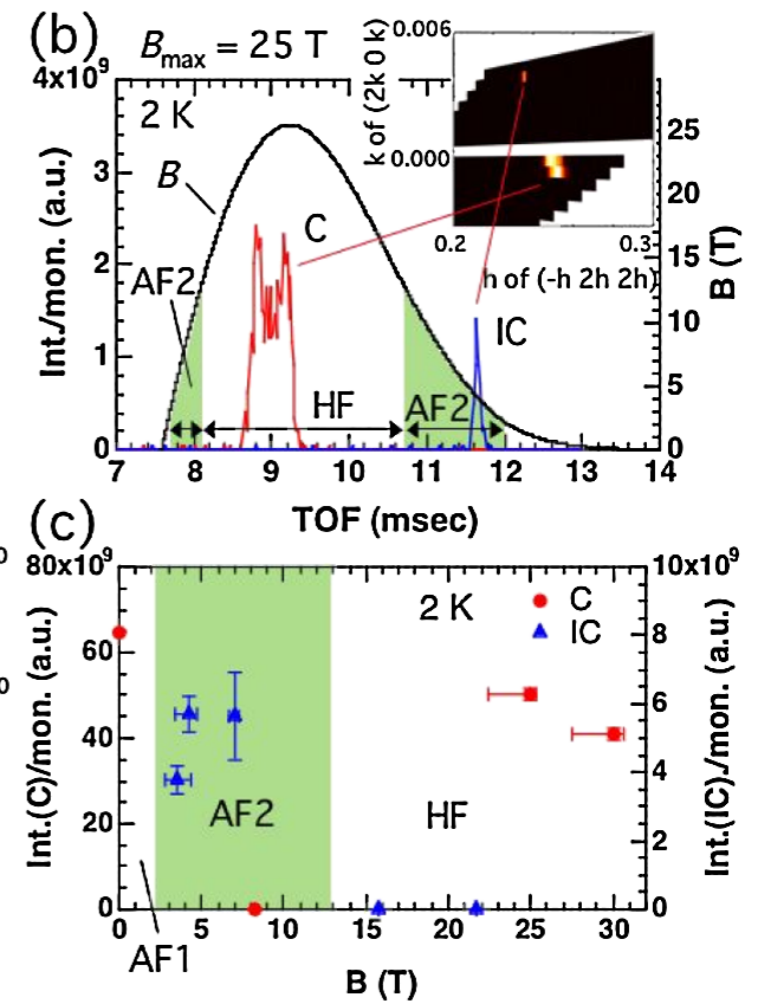
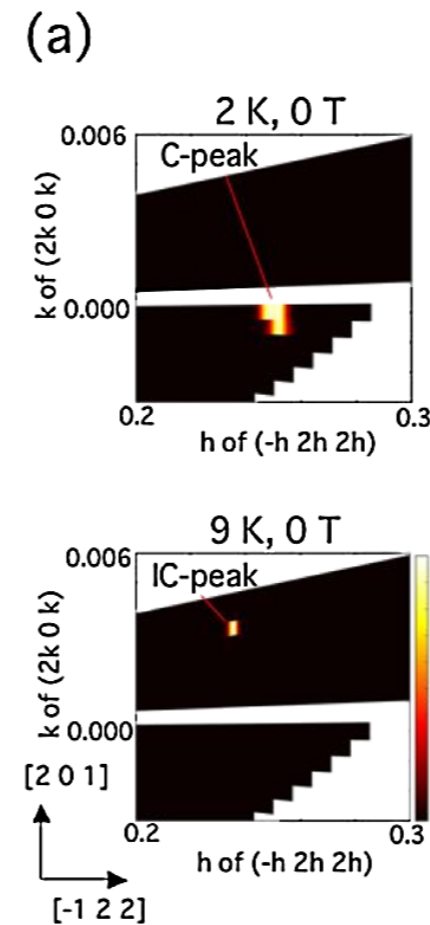
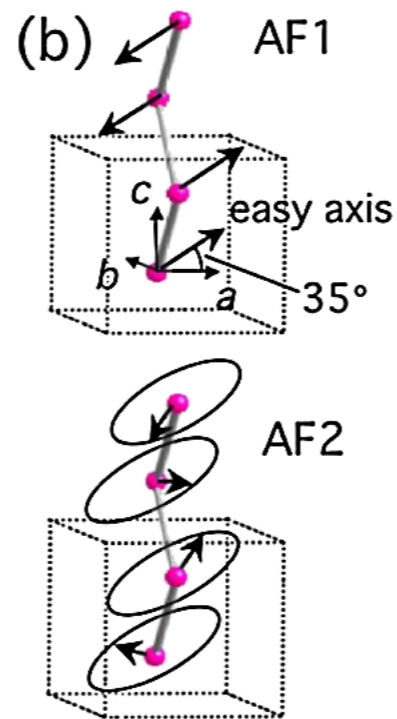
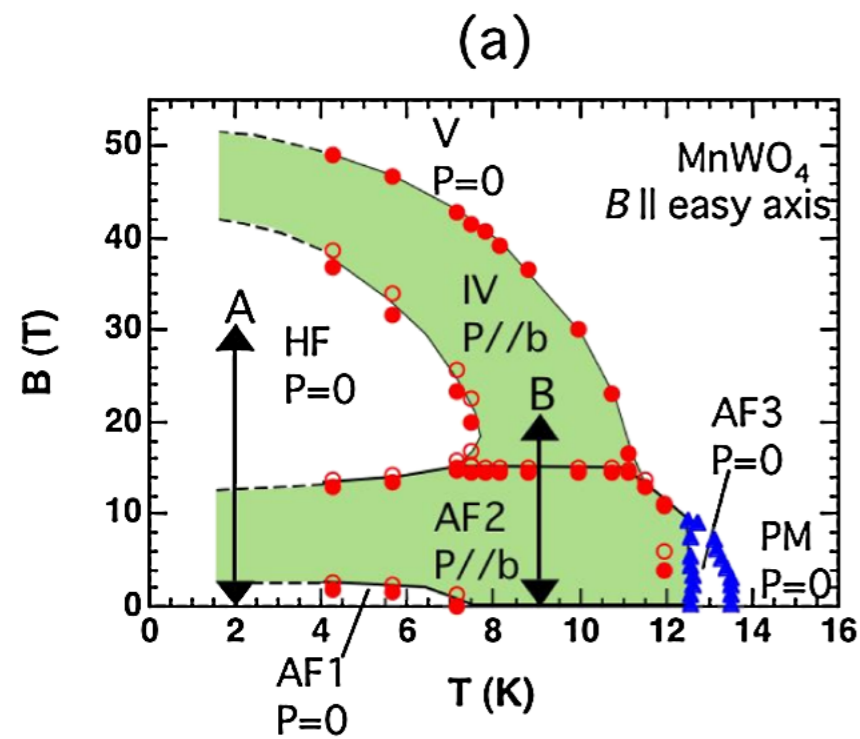
Magnetic diffraction from MnWO_4 to 30 T



Measurements on the SEQUOIA spectrometer at SNS
in “white” beam mode—Laue diffraction
5 min between magnetic pulses

H. Nojiri *et al.*,
Phys. Rev. Lett. **106**, 237202 (2011)

Magnetic diffraction from MnWO_4 to 30 T



H. Nojiri *et al.*,
Phys. Rev. Lett. **106**, 237202 (2011)

Proposal

- Neutron diffraction beam line
- 50 T pulsed magnet with decent rep rate
- Neutron pulse intensity sufficient to measure a diffraction peak within 12 hours (at 50 T)